COMPARISON OF SURFACE WATER, TISSUE, AND SEDIMENT ENDOSULFAN CONCENTRATIONS IN LABORATORY, MESOCOSM, AND FIELD STUDIES.

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ABSTRACT

Fate and transport of the agricultural pesticide endosulfan were assessed in laboratory aquaria and modular estuarine mesocosms. The results were then compared to field studies from tidal creeks adjacent to agricultural runoff areas. The purpose of this study was to evaluate the use of modular estuarine mesocosms designed to simulate a southeastern tidal creek ecosystem. Initial laboratory studies were performed in 20 gallon aquaria with fish and oysters exposed to seawater dosed with 0.2 µg/L of endosulfan daily for 96 hours. Daily water column endosulfan concentrations were monitored using GC-ECD and averaged 0.026 µg/L. Bioconcentration factors (BCFs) ranging from 2180 to 2750 were calculated for fish and oysters at 96 hours. For the mesocosm studies, test chambers were constructed which contained a tidal channel, mid, low, and high marsh components, along with tidal flux. Mesocosm components (sediments, marsh plants and animals) were collected from a historically pristine salt marsh on Wadmalaw Island, SC and established in the mesocosms. Mesocosm units dosed at a variety of endosulfan concentrations ranging from 0.017 to 3.3 µg/L. Water, sediment, and tissue samples were collected for GC-ECD analysis at 0 and 96 hours after the initial dose. Water column endosulfan I & II concentrations decreased rapidly and independent of dose. This decrease was primarily due to tidal dilution and partitioning with biota, sediments and tank materials. Approximated mesocosm and field BCF values (mean) for oysters were 333 and 271 for total measured endosulfan, respectively. This suggests that the mesocosm units provide an adequate simulation of field exposure conditions.

OBJECTIVE

The purpose of this study was to evaluate the use of a modular estuarine mesocosm designed to simulate a southeastern tidal creek ecosystem. More specifically, do tidal creek organisms in a mesocosm accumulate pesticides in a similar manner to that observed under field conditions or laboratory conditions?

METHODS

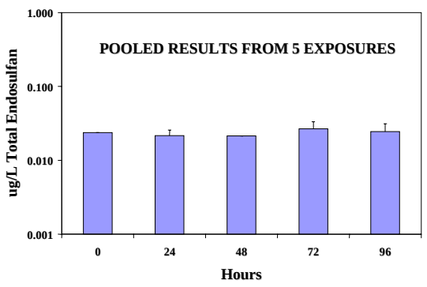
- Field studies were conducted by NOAA and Univ. of South Carolina (Scott et al. 1992, 1989) on Wadamalaw Island, SC
  - Samples were collected from three sites.
    - CTL Site - no agricultural input
    - TRT Site - intensive agriculture
    - KWA Site - intensive agriculture
  - Samples were collected for chemical analysis: using:
    - Surface Water GC-ECD
    - Sediments GC-ECD
    - Oyster Tissues - *Crassostrea virginica* GC-ECD
- Laboratory Aquarium Study
  - Oysters (*C. virginica*)and fish (*Fundulus heteroclitus*) were exposed to endosulfan over a 96 hour time period. The experiment consisted of one control tank and one treatment tank. The treatment tank was dosed daily with 0.2 µg/L endosulfan in order to maintain concentration. Water and tissues were analyzed for total endosulfan using GC-ECD.
- Mesocosm Study
  - Modular estuarine mesocosms were used to represent an endosulfan field exposure. Mesocosms were dosed daily at the following treatment concentrations: control, 0.017, 0.033, 0.067, 0.367, 1.102, and 3.340 µg/L. The design for the mesocosms is modified from Lauth et al. (1996). Rather than a flow through design, a replicated design was employed. Water, sediment, and tissues were analyzed for total endosulfan using GC-ECD.

RESULTS

LABORATORY STUDY

76 liter aquaria

WATER RESIDUES

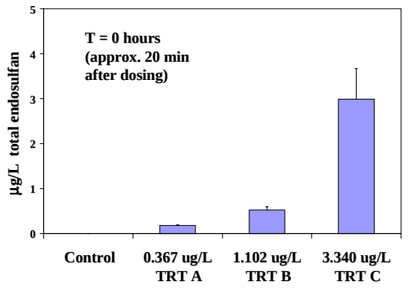


MESOCOSM STUDY

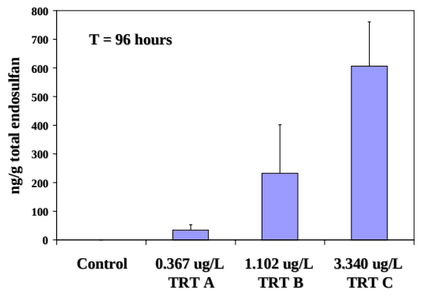
Modular Estuarine Simulations

96 hour Acute Study

WATER RESIDUES



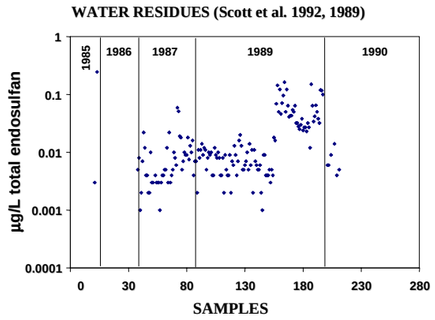
OYSTER TISSUE RESIDUES



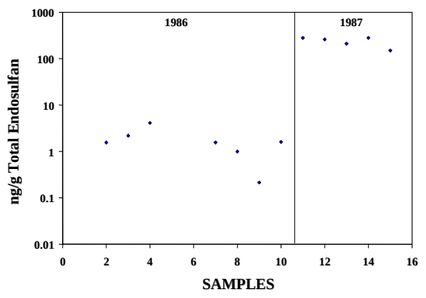
FIELD STUDIES

Wadamalaw Island, SC

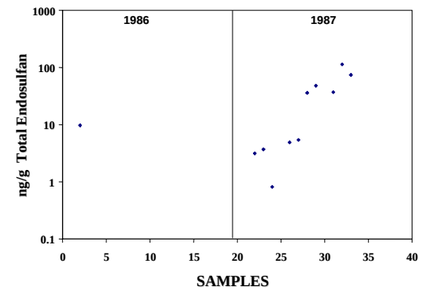
WATER RESIDUES (Scott et al. 1992, 1989)



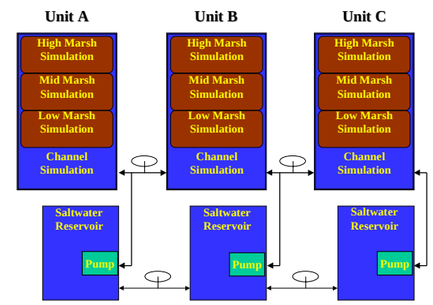
SEDIMENT RESIDUES (Scott et al. 1992, 1989)



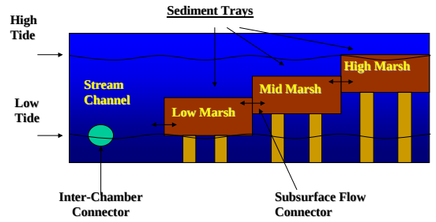
OYSTER RESIDUES (Scott et al. 1992, 1989)



TOP-VIEW OF REPLICATED MESOCOSM DESIGN



SIDE-VIEW OF INDIVIDUAL MESOCOSM UNIT



CONCLUSIONS

- Preliminary mesocosm results indicate that laboratory studies may over-estimate BCFs.
  - Field derived BCF values for total endosulfan from the studies of Scott et al. (1992, 1989) average 271 for oysters.
  - Laboratory aquarium studies over-estimated BCF value for total endosulfan when compared to the Field derived data.
  - The laboratory (aquarium) derived BCFs in this study (2465 and 2661 for oysters and fish, respectively) were similar to that of Schimmel et al. 1977 (BCF Range = 829 to 2755) for the 'whole body' estimate from the mullet *(Mugil cephalus)*.
  - The mesocosm derived BCF from this study is similar to the work of Scott et al. (1992, 1989) with a mean BCF value of 333 across the various concentrations tested. This value is very similar to the mean field derived BCF value (271) observed by Scott et al. (1992, 1989).
- Based on this data, the modular estuarine mesocosm design and study employed here represents a realistic approach for assessing the movement of endosulfan within a Southeastern estuarine tidal marsh.
- Work in Progress with regard to this mesocosm study:
  - Chronic (21 Day) Study sample and data analysis
  - Sediment endosulfan concentrations
  - Tissue endosulfan concentrations for:
    - Fish -- *Fundulus heteroclitus*
    - Shrimp -- *Palaemonetes pugio*
    - Crabs -- *Uca pugilator*
  - Nutrient chemistry
  - Biological and Toxicity test data
  - Water Quality Data

SUMMARY TABLE:

Comparison of Field Data, Laboratory Data and Preliminary Mesocosm Data

	Water (µg/L) NOMINAL Total Endosulfan	TOTAL ENDOSULFAN (MEASURED) Water (µg/L) x̄ ± SE	Sediment (ng/g) x̄ ± SE	Tissue (ng/g) x̄ ± SE	BCF Based on Measured Concentration x̄ ± SE
FIELD Study Wadamalaw Island, SC 1985-1990	**N/A**	**0.017 ± 0.002** min. < 0.001 max. = 0.245	**79.5 ± 30.6** min. < 0.1 max. = 280	*Oysters:* **9.87 ± 4.23** min. < 0.1 max. = 113	*Oysters:* **271 ± 71.3** min. = 92 max. = 1800
Laboratory Aquarium Study *96 hours*	0.2 µg/L	**0.024 ± 0.001** min. = 0.018 max. = 0.033	**N/A**	*Oysters:* **58.91 ± 9.6** *Fish:* **63.59 ± 1.8**	*Oysters:* **2465 ± 402** *Fish:* **2661 ± 75.7**
MESOCOSM Chronic Study *21 Days*	0.017 µg/L 0.033 µg/L 0.067 µg/L	< 0.001 **0.020 ± 0.010** **0.044 ± 0.021**	*Work In Progress*	*Work In Progress*	*Work In Progress*
MESOCOSM Acute Study *96 hours*	0.367 µg/L 1.102 µg/L 3.340 µg/L	**0.176 ± 0.019** **0.521 ± 0.076** **2.98 ± 0.679**	< 41.01 ** < 31.00 ** < 24.99 **	*Oysters:* **34.5 ± 18.5** **232 ± 170** **605 ± 154**	*Oysters:* **176 ± 95.2** **580 ± 473** **241 ± 86** **Overall BCF** **333 ± 155**

** (These samples are being re-analyzed to improve MDLs)